Modeling for Ozone and $PM_{2.5}$

Chris Salmi, NJDEP
Division of Air Quality

May 17, 2006

Overview

- Ozone Modeling
  - Base Case
  - Sensitivity Analysis
- Preliminary Fine Particulate Matter ($PM_{2.5}$) Modeling

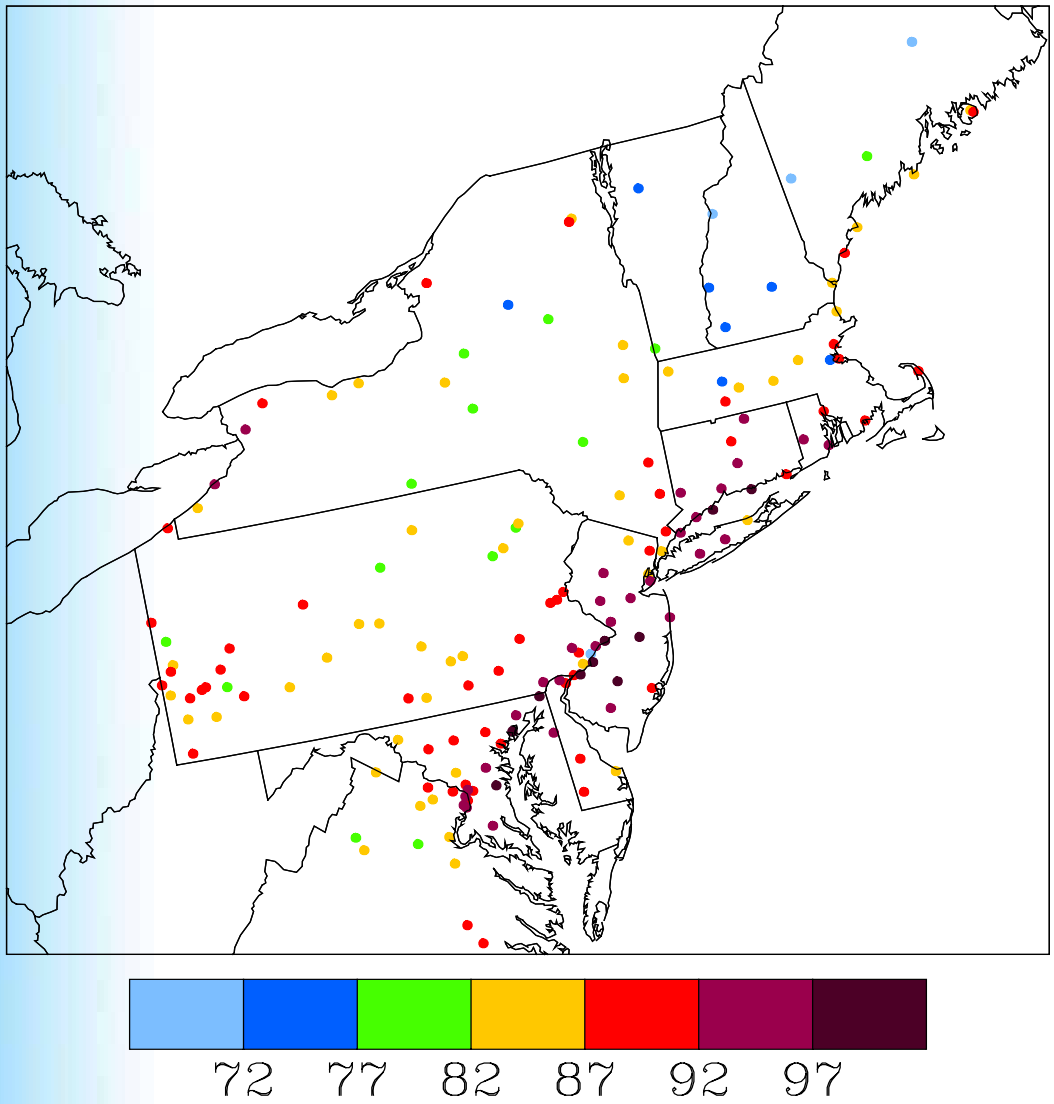
Ozone Modeling

Modeling Platform

- Model: CMAQ – Community Multiscale Air Quality Model, Version 4.4
- Time Period: 2002
- Emissions: MANE-VU, LADCO, VISTAS
- Meteorology: MM5

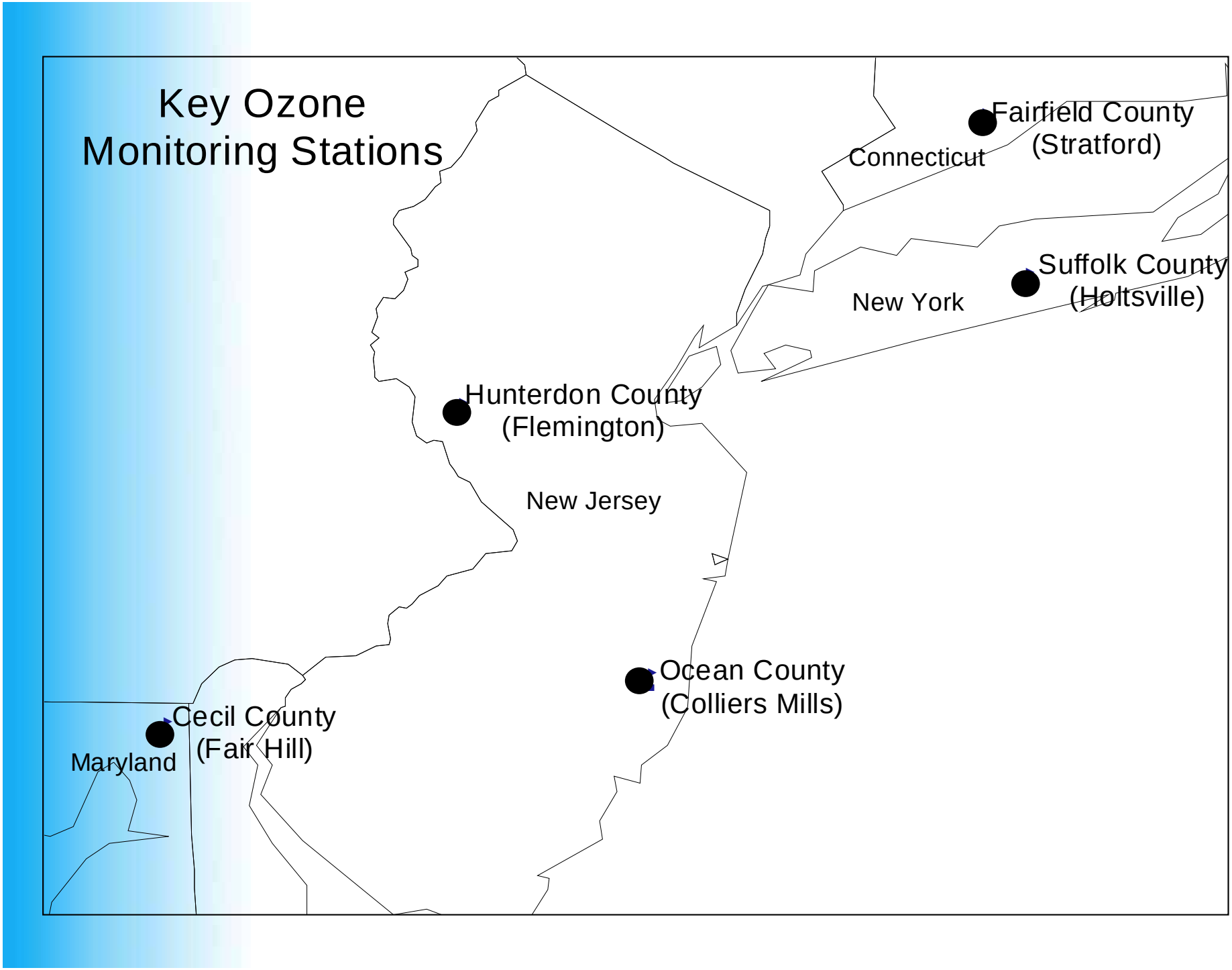
Bottom Line: SIP Quality Platform

“8-Hour Modeling Design Values”



Average of 8-hr O_3 Design Values for 2000-2002, 2001-2003, and 2002-2004

These “Design Values” are used for the purpose of the modeled attainment test


Key Ozone
Monitoring Stations
Fairfield County
(Stratford)
Connecticut
Suffolk County
(Holtsville)
New York
Hunterdon County
(Flemington)
New Jersey
Ocean County
(Colliers Mills)
Cecil County
(Fair Hill)
Maryland

Ozone Modeling Design Values 2000 - 2004

Key Monitors	Concentration (ppb)
Fairfield County (Stratford), CT	98.3
Suffolk County (Holtsville), NY	97.0
Hunterdon County (Flemington), NJ	95.3
Ocean County (Colliers Mills), NJ	106.0
Cecil County (Fair Hill), MD	97.7

Attainment Demonstration Technique

- Use Ozone modeling results in a relative manner
- Create a Relative Reduction Factor

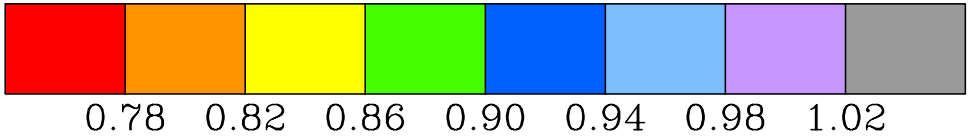
$$RRF = \frac{\text{Modeling Results Future Year}}{\text{Modeling Results Base Year}}$$

- Predicted Concentration =

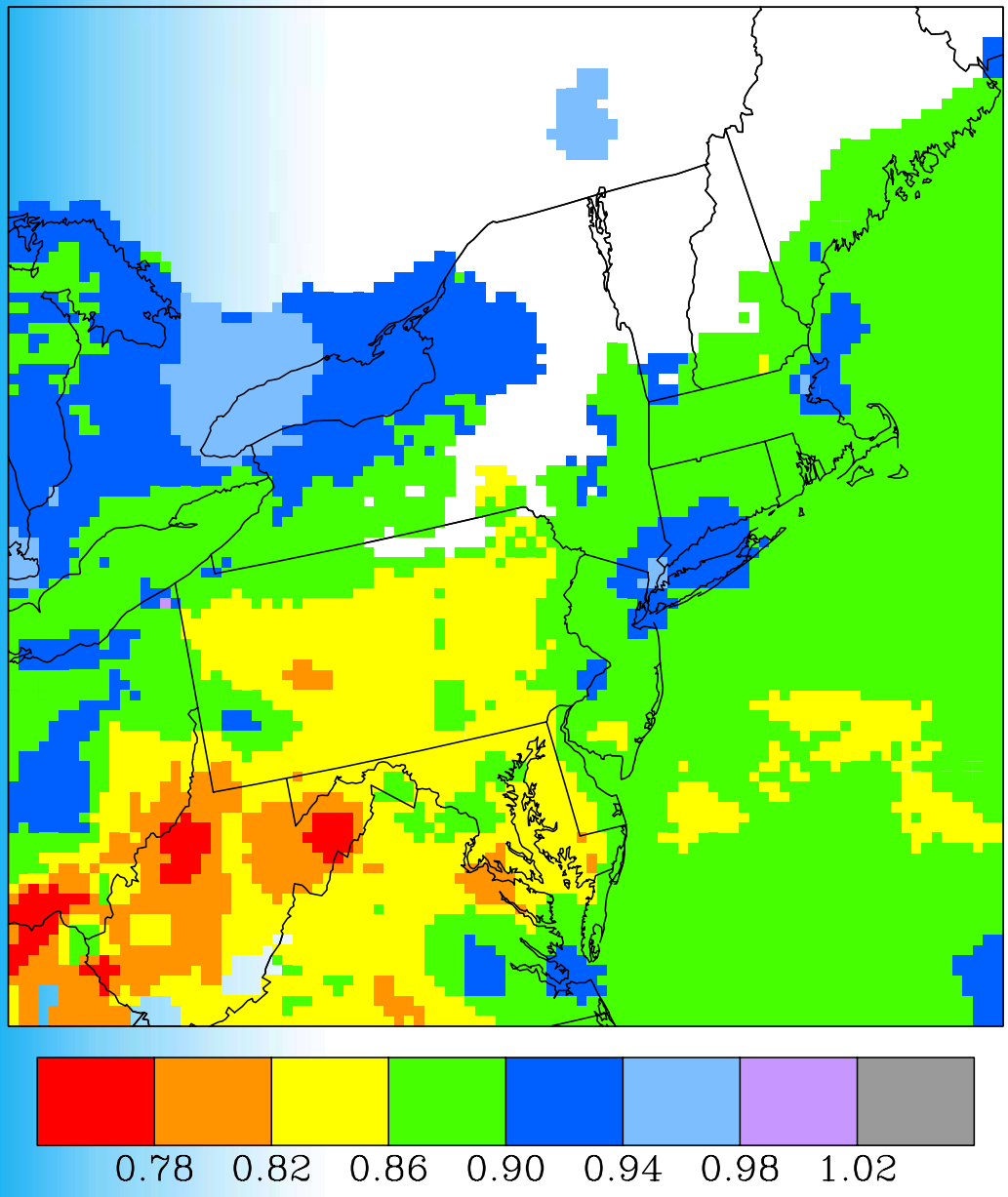
RRF * Modeling Design Value

To meet attainment, we need ...

Key Monitors	Concentration (ppb)	RRF Needed
Fairfield County (Stratford), CT	98.3	0.86
Suffolk County (Holtsville), NY	97.0	0.87
Hunterdon County (Flemington), NJ	95.3	0.89
Ocean County (Colliers Mills), NJ	106.0	0.80
Cecil County (Fair Hill), MD	97.7	0.86



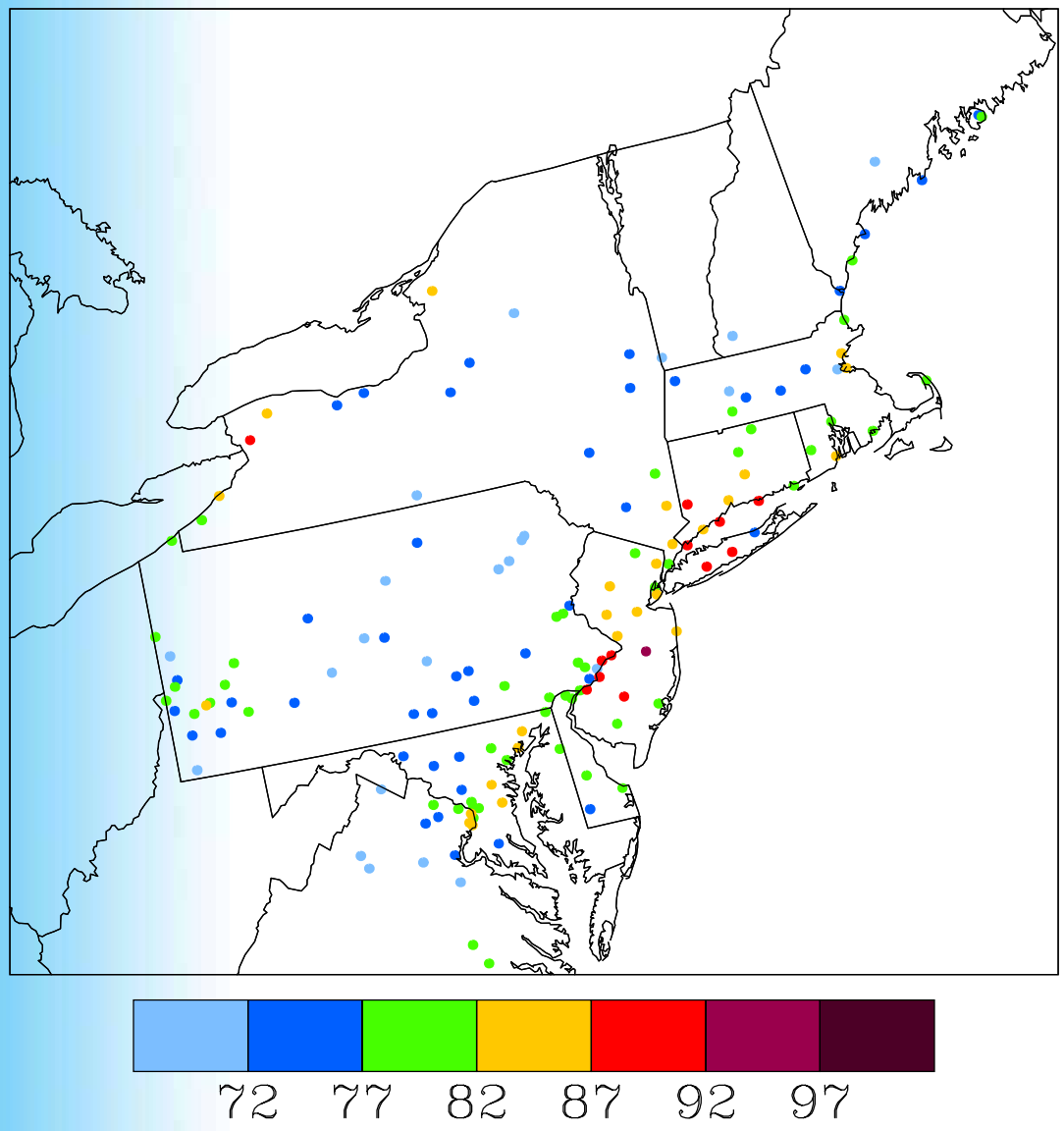
Relative Reduction Factors (RRF) for the 2002 Base and the 2009 Future Base Cases



Control Measures

- Clean Air Interstate Rule (CAIR)
- Architectural Coatings
- Consumer Products
- Portable Fuel Containers (PFC)
- Solvent Cleaning
- Additional NO_x Controls
- Mobile Equipment Repair and Refinishing
- Tier II Onroad Light Duty Vehicle Emission Standards and Low Sulfur Gasoline
- Onroad Diesel Emission Standards and Ultra Low Sulfur in Fuel
- Nonroad Diesel Emission Standards and Ultra Low Sulfur in Fuel
- Nonroad Spark Ignition Engine Standards (small, large and marine)

2009 Future Base Case

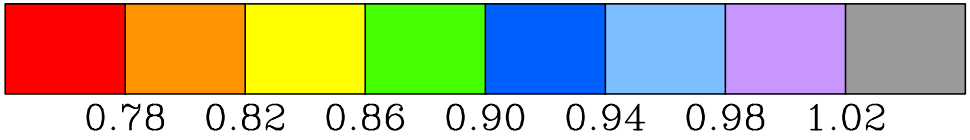


- These values represent the “Future Design Values” for the purpose of the modeled attainment test.
- For values between 82 and 87 ppb, states must submit a weight of evidence attainment demonstration.

2009 Future Base Case

Key Monitors	Concentration (ppb)	RRF Needed	RRF Predicted	Future Design Value
Fairfield County (Stratford), CT	98.3	0.86	0.93	91.4
Suffolk County, (Holtsville) NY	97.0	0.87	0.93	90.3
Hunterdon County (Flemington) NJ	95.3	0.89	0.88	83.9
Ocean County, NJ (Colliers Mills)	106.0	0.80	0.88	92.9
Cecil County, (Fair Hill) MD	97.7	0.86	0.83	80.7

A lower RRF means lower ozone concentrations.



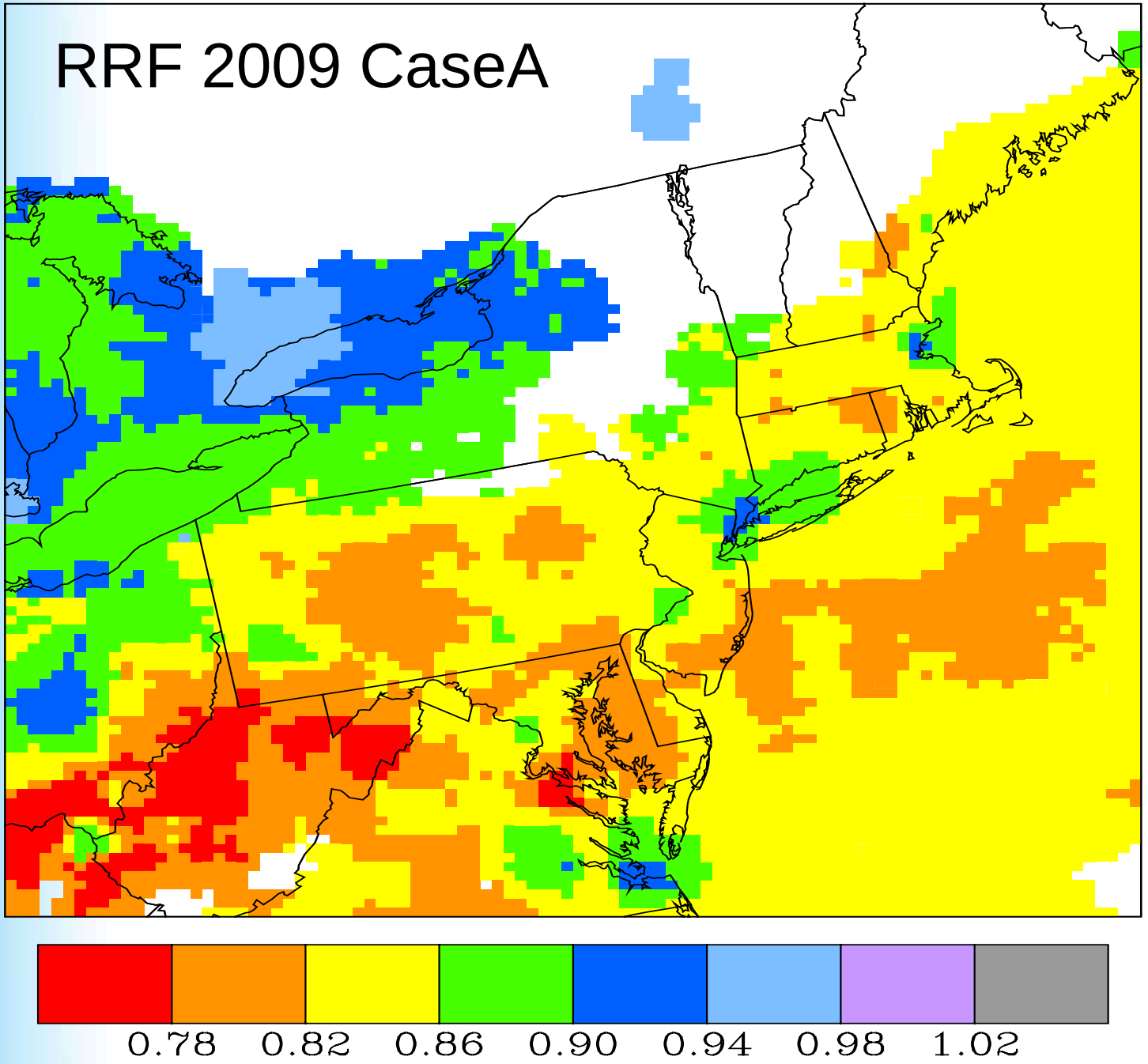
Sensitivity Analyses

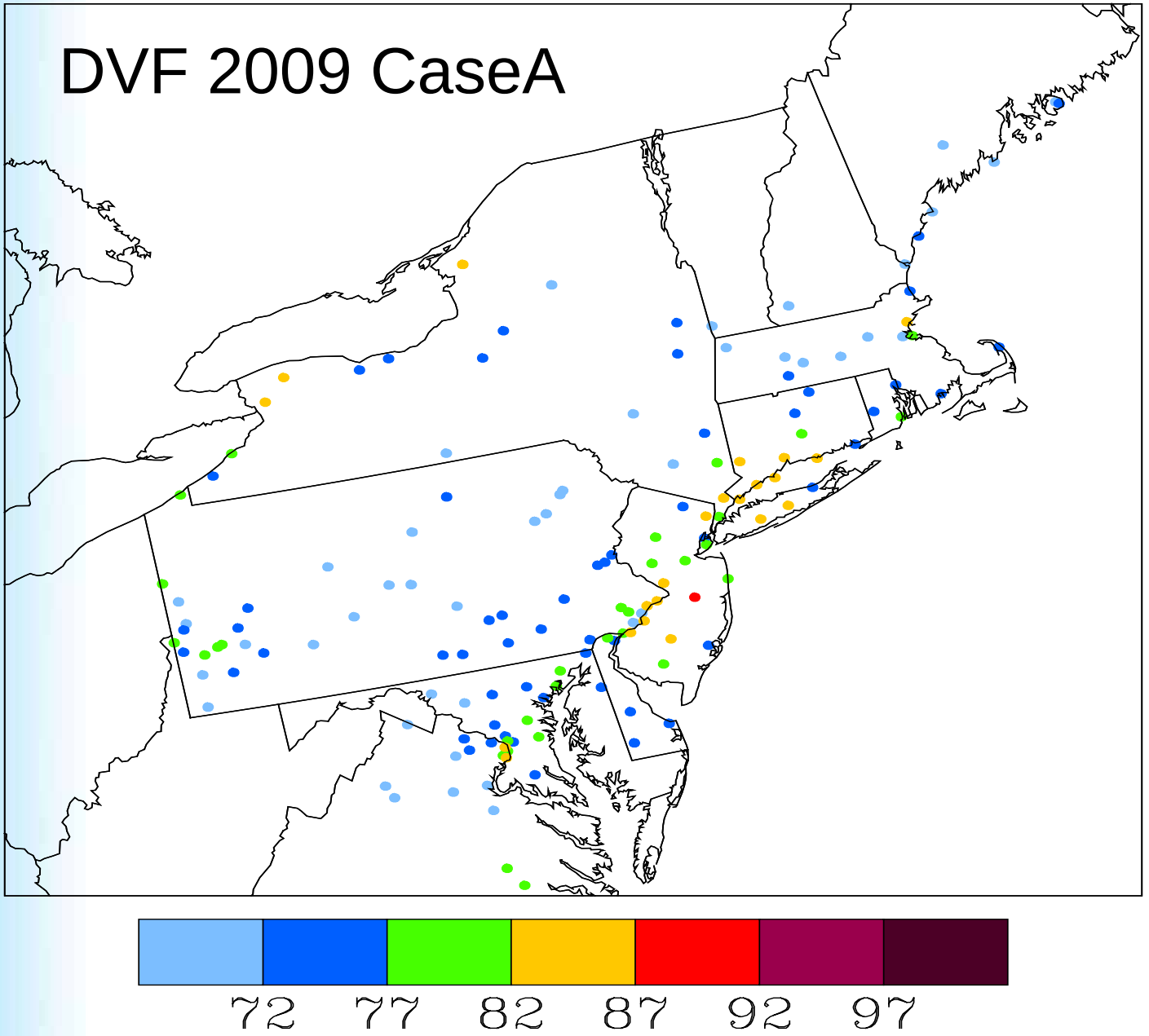
- Inventory Category Reductions
  - Case A – Steep Reductions in the OTR Inner Corridor
  - Case B – Reductions in the MANE-VU Region
    - Approximates OTC Regional Measures
- High Electric Demand Days
  - Electric Generating Utilities (EGUs)

Category Reductions

Emission Reductions Relative to the 2009 Future Base Case

Category	CaseA
Area Sources	30% VOC/CO/NO_x reductions within the inner OTR corridor
Nonroad Sources	30% VOC/CO/NO_x reductions within the inner OTR corridor
Mobile Sources	No reductions
Non-EGU Point Sources	30% VOC/CO/NO_x reductions within the inner OTR corridor
EGU Point Sources	30% VOC/CO/NO_x reductions domain-wide

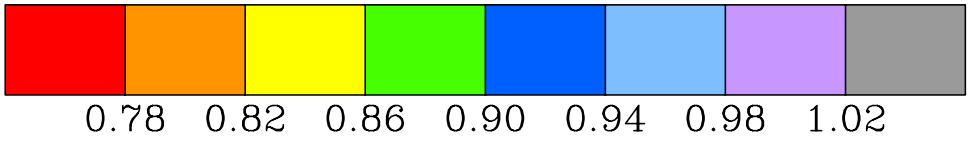

RRF 2009 CaseA
0.78
0.82
0.86
0.90
0.94
0.98
1.02


DVF 2009 CaseA
72
77
82
87
92
97

Future Case A
Reductions in the Inner OTR Corridor

Key Monitors	Concentration (ppb)	RRF Needed	CaseA RRF Predicted	Future Design Value
Fairfield County (Stratford), CT	98.3	0.86	0.89	87.0
Suffolk County, (Holtsville) NY	97.0	0.87	0.89	86.2
Hunterdon County (Flemington) NJ	95.3	0.89	0.84	80.1
Ocean County, NJ (Colliers Mills)	106.0	0.80	0.83	88.4
Cecil County, (Fair Hill) MD	97.7	0.86	0.79	76.9

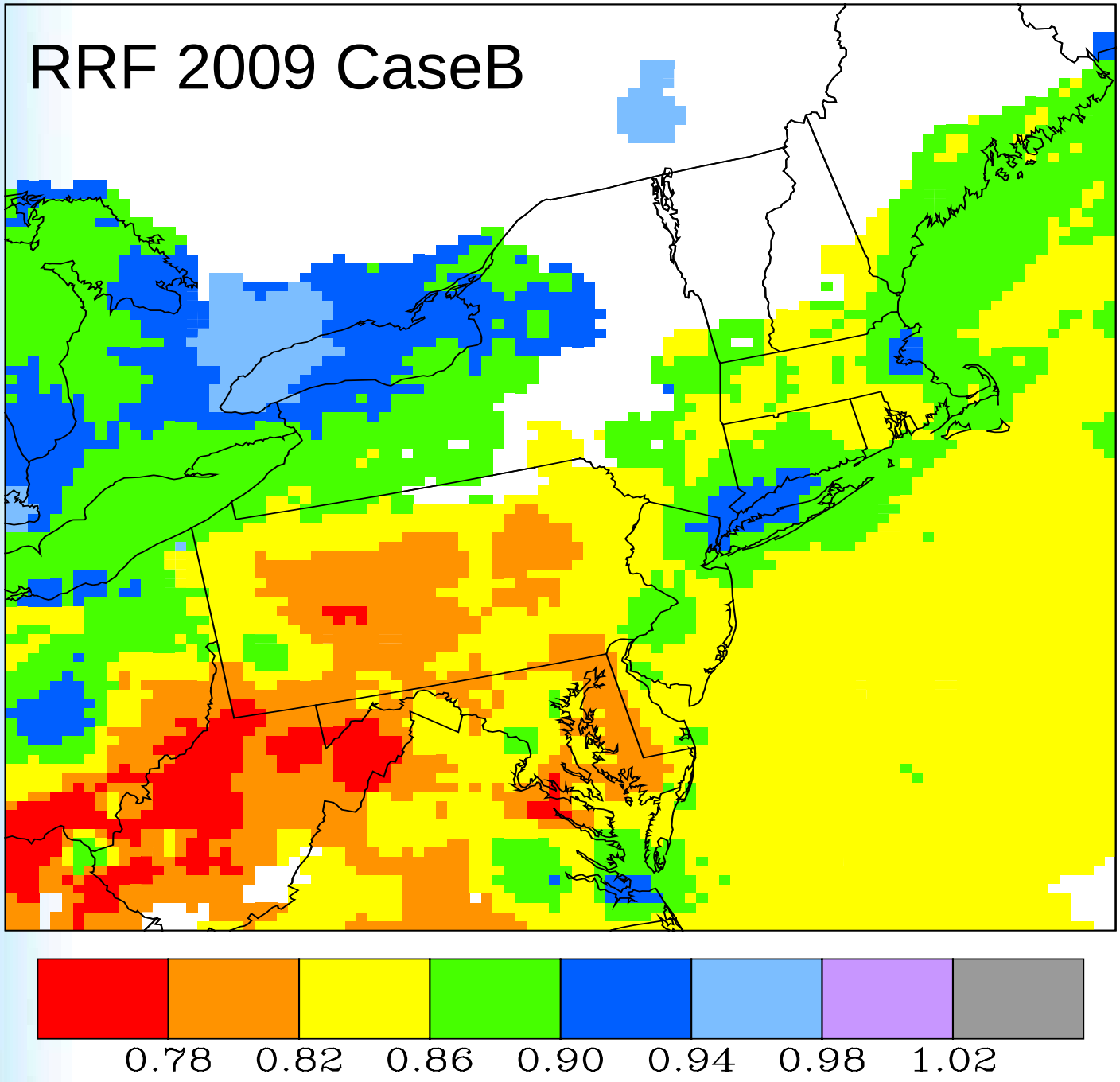
A lower RRF means lower ozone concentrations

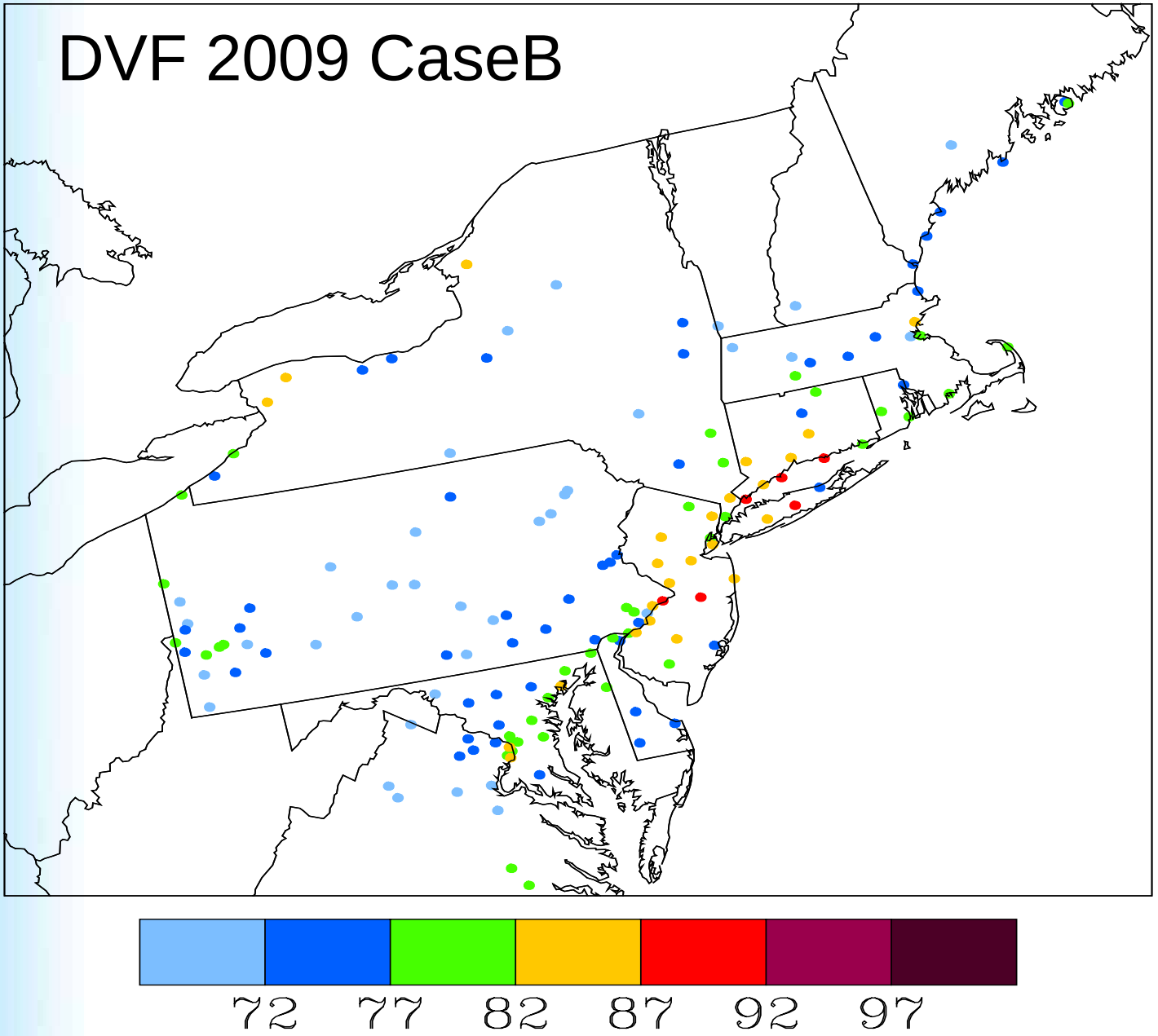


Category Reductions

Emission Reductions Relative to the 2009 Future Base Case

Category	Case B
Area Sources	10% VOC/CO reductions across the entire MANE-VU region
Nonroad Sources	No reductions
Mobile Sources	No reductions
Non-EGU Point Sources	30% NO_x reductions across the entire MANE-VU region
EGU Point Sources	30% VOC/CO/NO_x reductions domain-wide

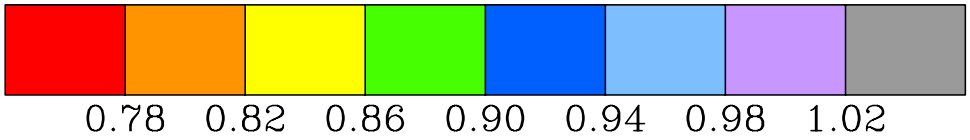

RRF 2009 CaseB
0.78
0.82
0.86
0.90
0.94
0.98
1.02


DVF 2009 CaseB
72
77
82
87
92
97

Future Case B
Reductions in the MANE-VU Region

Key Monitors	Concentration (ppb)	RRF Needed	CaseB RRF Predicted	Future Design Value
Fairfield County (Stratford), CT	98.3	0.86	0.91	89.8
Suffolk County, (Holtsville) NY	97.0	0.87	0.91	88.6
Hunterdon County (Flemington) NJ	95.3	0.89	0.86	82.0
Ocean County, NJ (Colliers Mills)	106.0	0.80	0.86	90.7
Cecil County, (Fair Hill) MD	97.7	0.86	0.80	78.4

A lower RRF means lower ozone concentrations



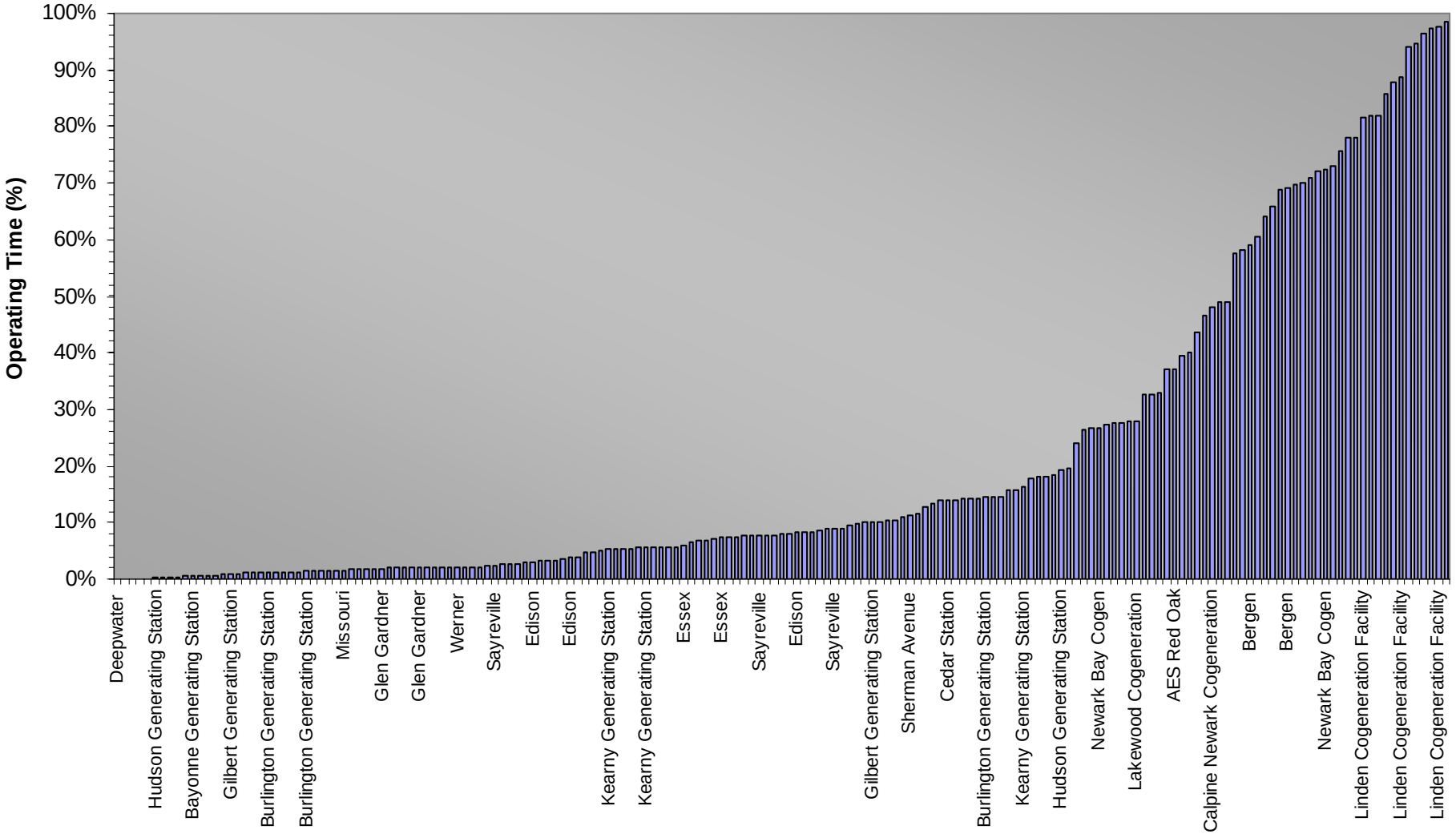
Conclusions Thus Far

- Existing control measures “On the Way” and “On the Books” will not bring the region into attainment.
- Steep across the board emission reductions appear to be necessary

Sensitivity Analysis -

High Electric Demand Days

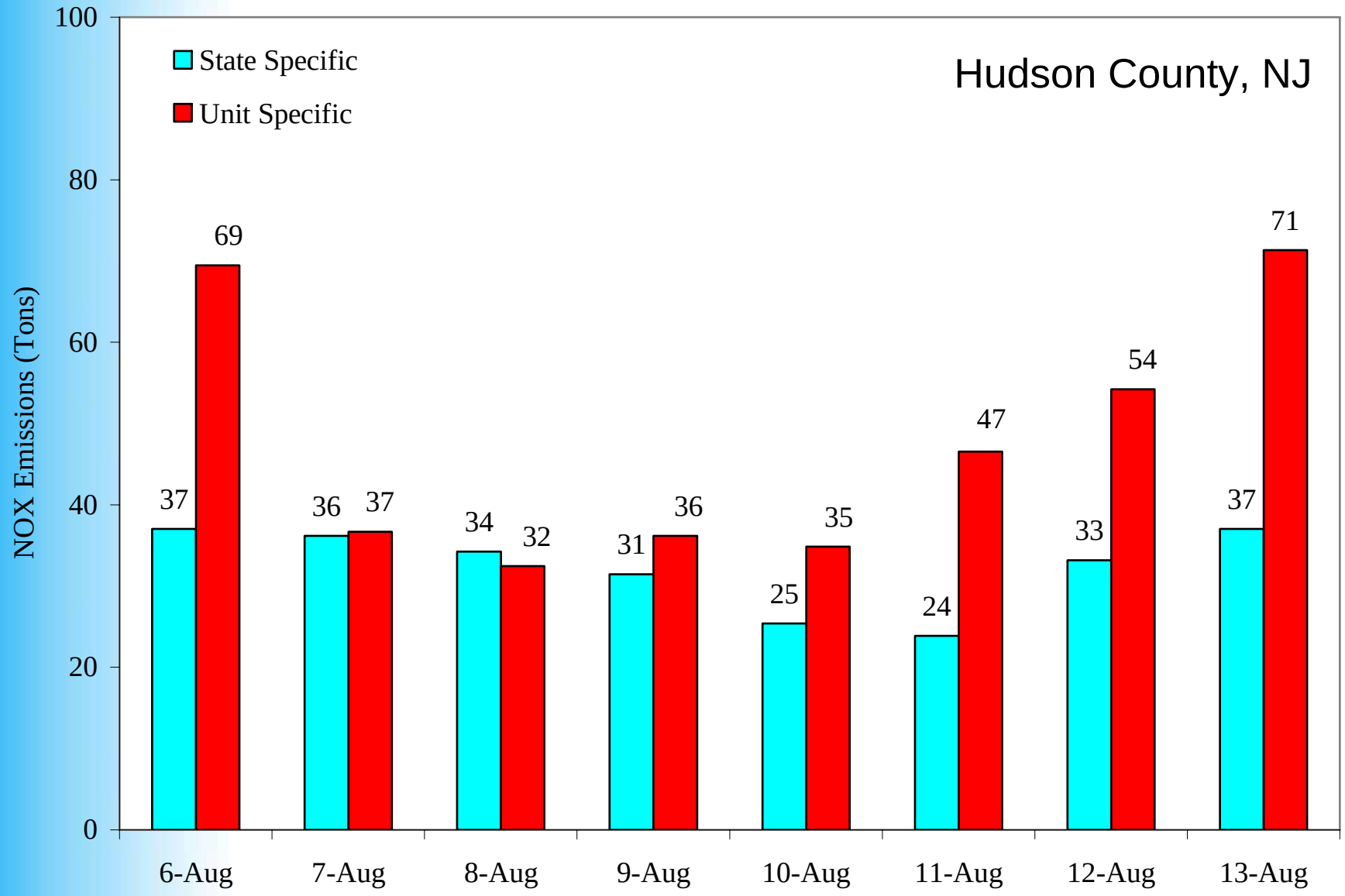
NJ Electric Generating Utility Average Percent Operating Time
2002-2005 Ozone Seasons



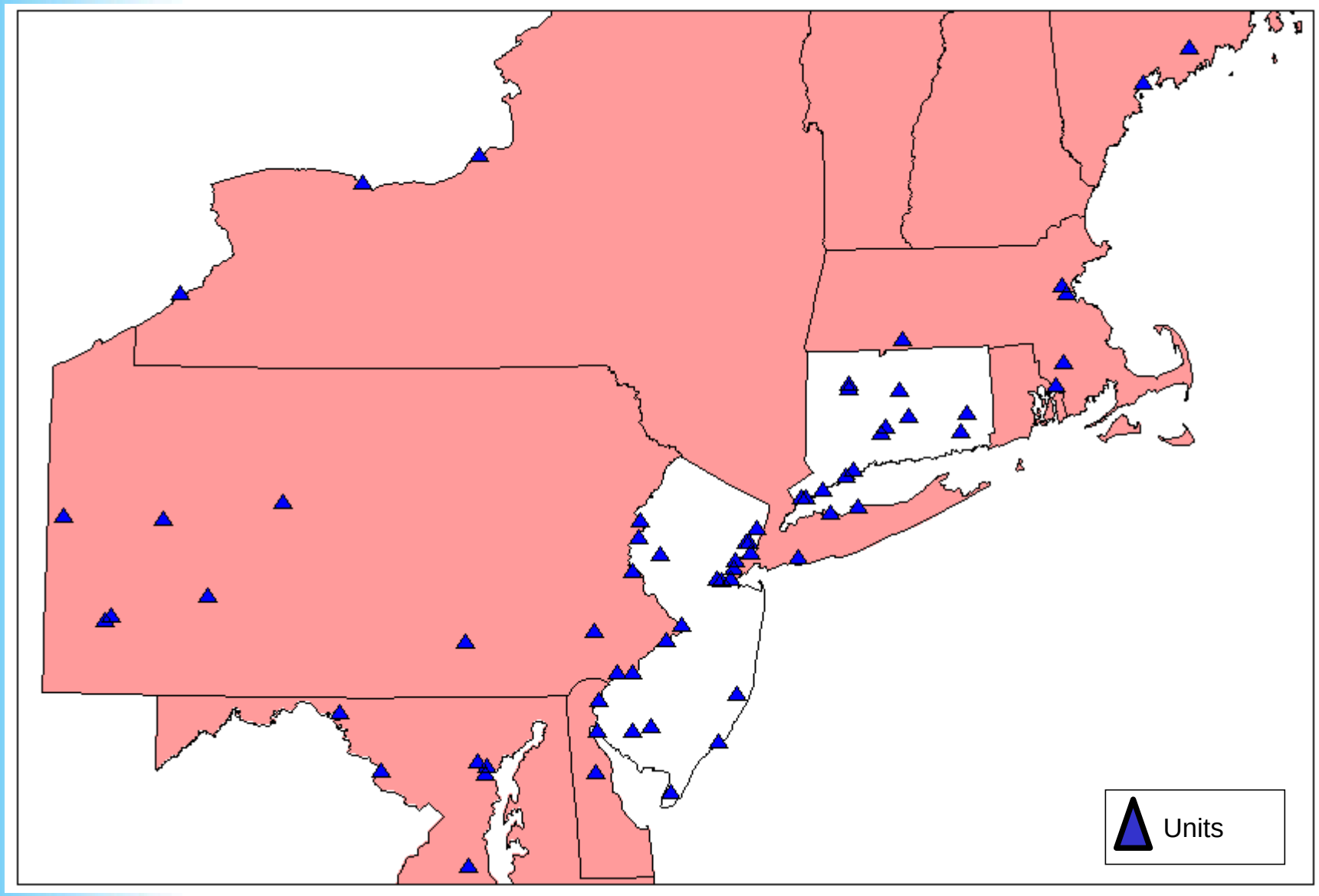
High Electric Demand Day Sensitivity Analysis - Episodic Modeling

- Utilized SIP Quality Modeling Platform
- August 1 - 15, 2002
- Unit Specific Emissions Incorporated
- Focused on emission units which operate on a few days of the year

Impact on NO_X Emissions



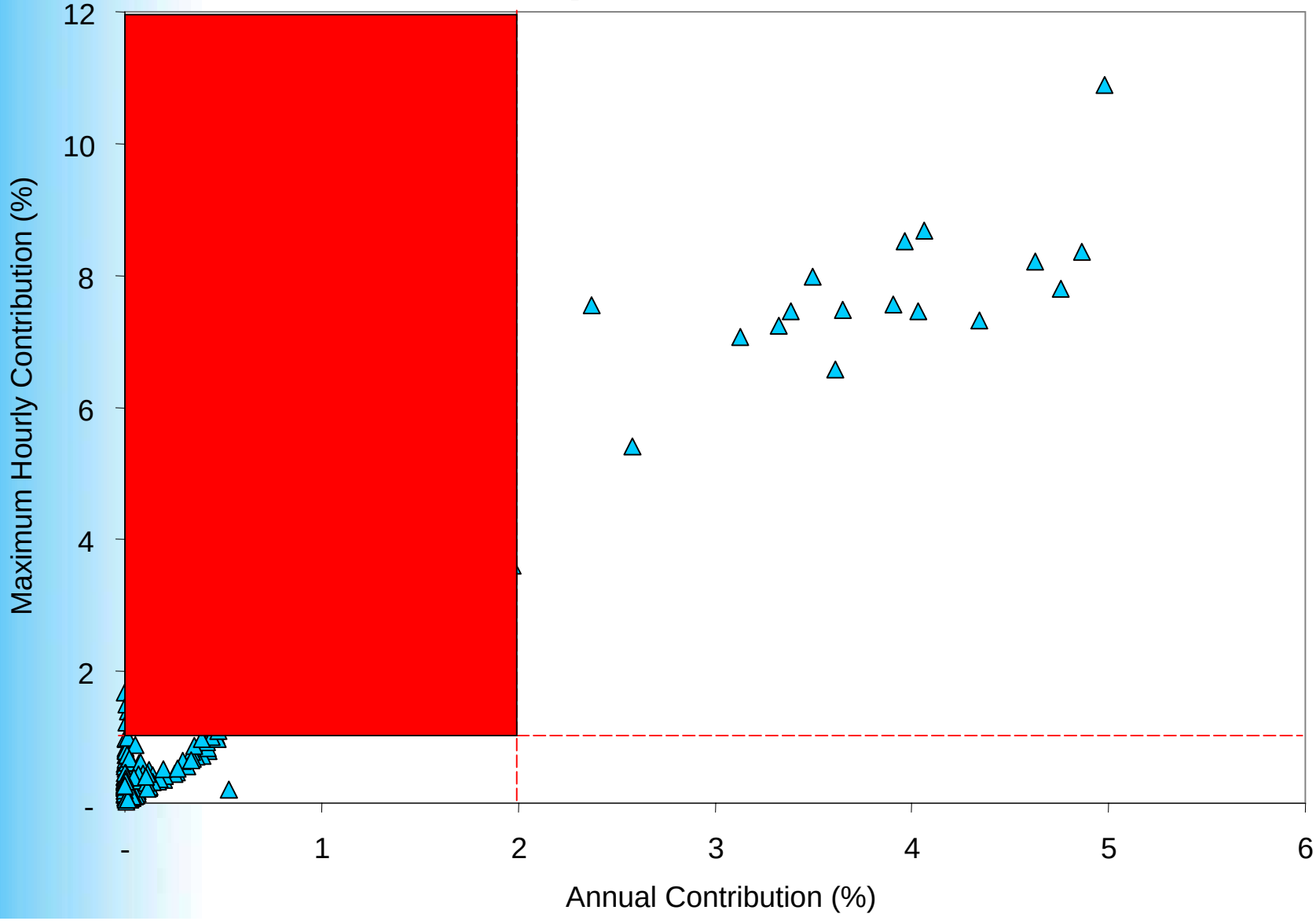
High Electrical Demand Day Units



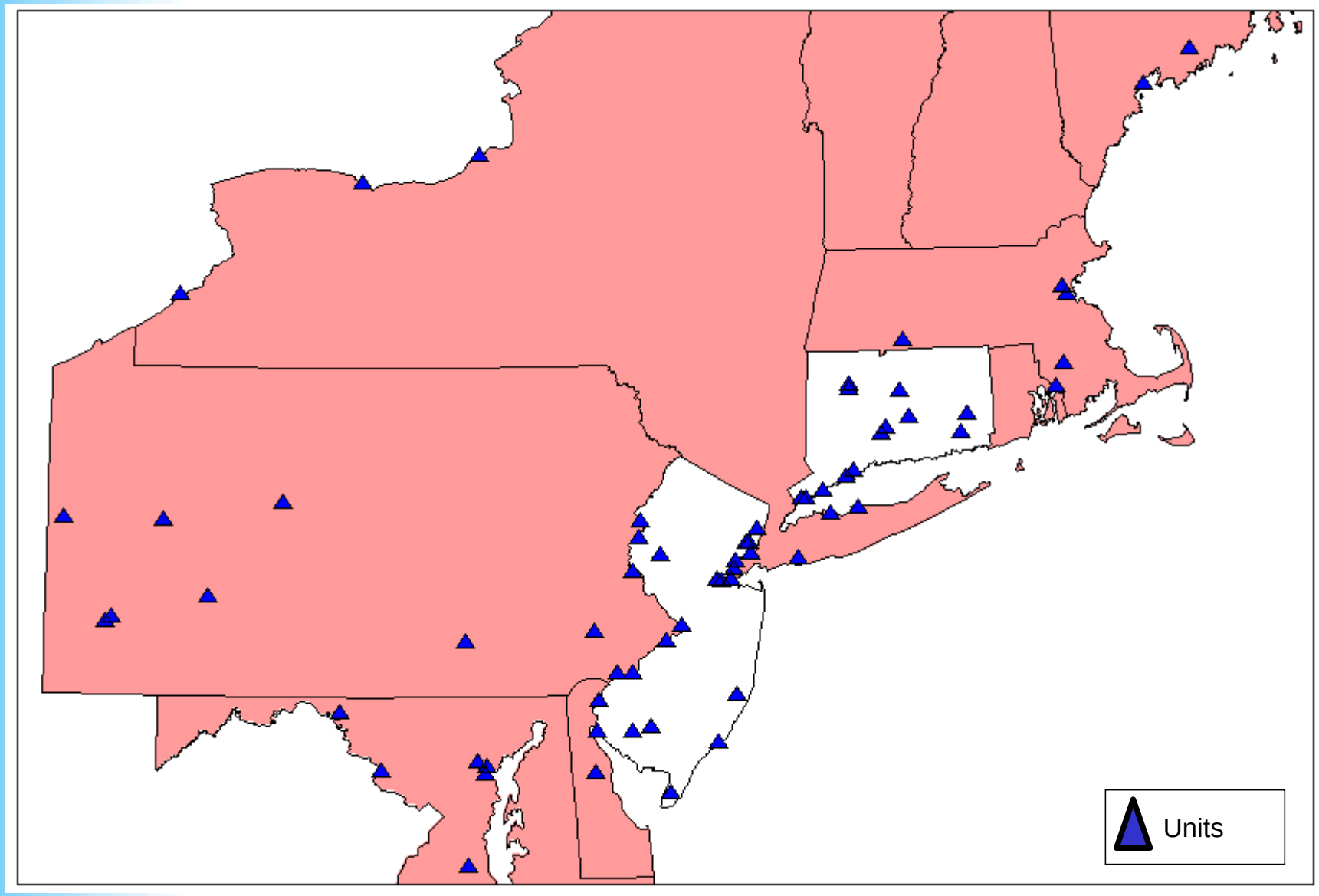
What Happened in NJ & CT?

- States took closer look at units operating on high electrical demand days, 2002-5 ozone seasons
- New Jersey
  - Units whose average operating time is ~ < 20%
- Connecticut
  - Units whose average operating time is ~ < 50%

Units Identified in All States Except NJ & CT



High Electrical Demand Day Units

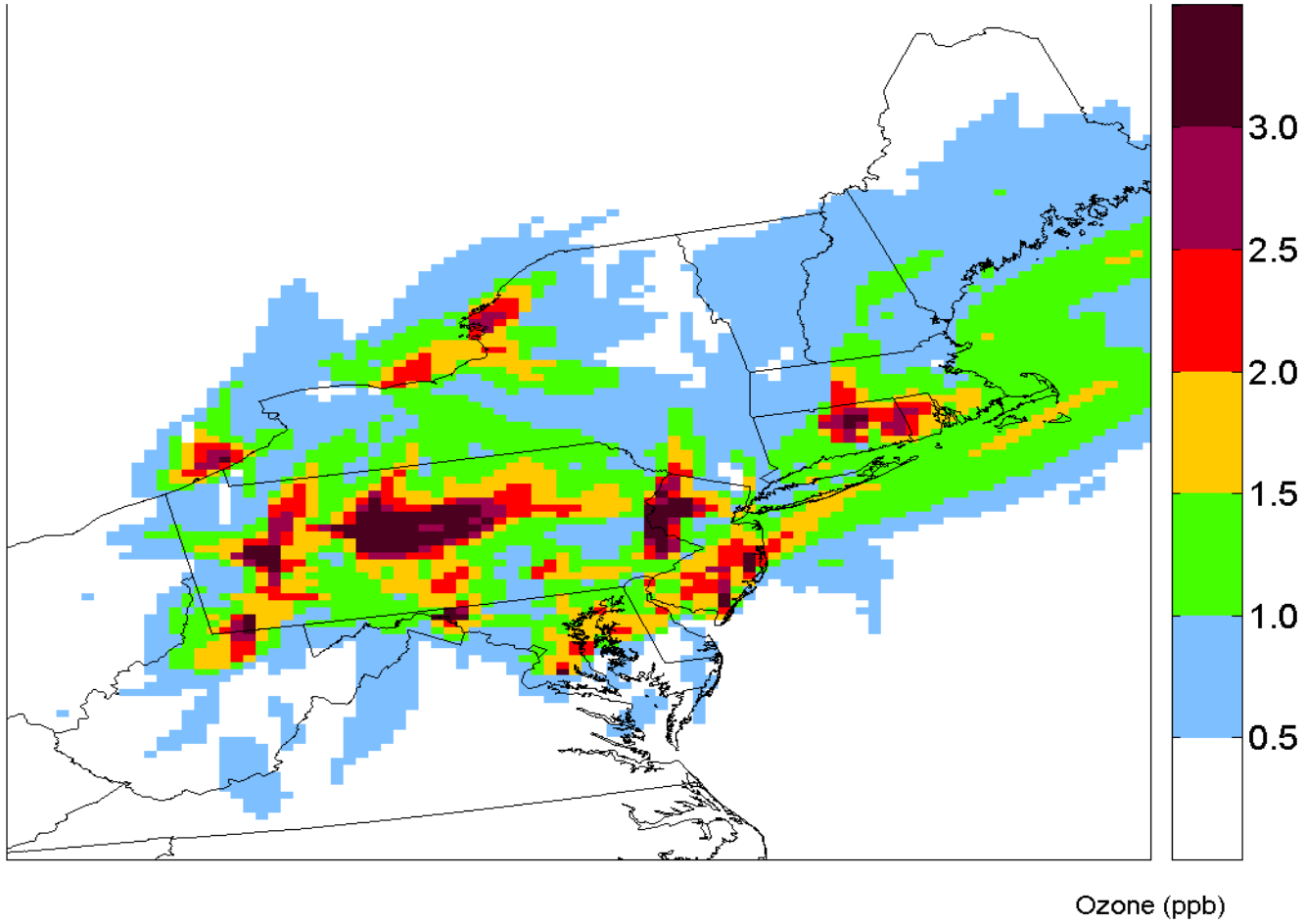


Control Level

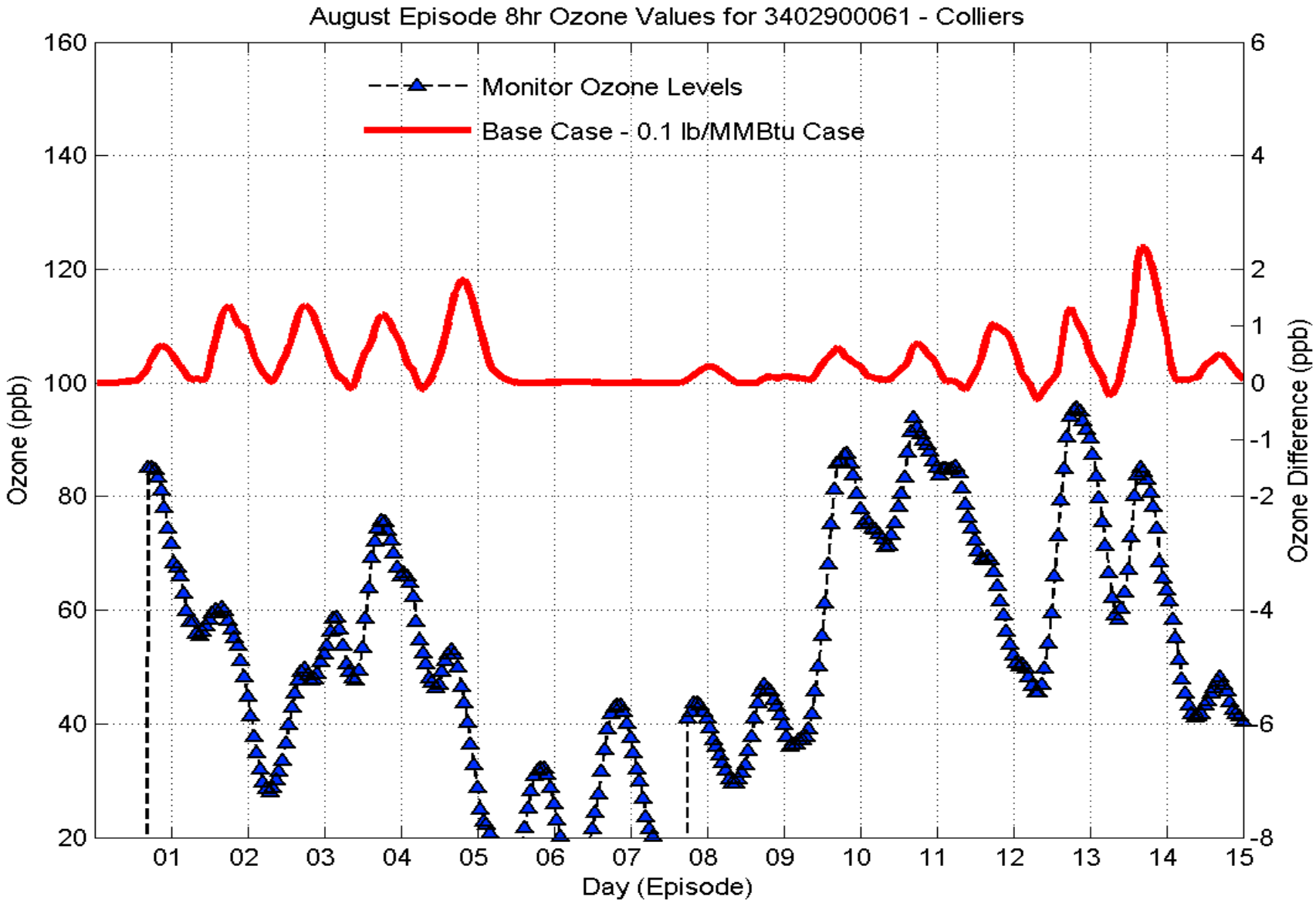
- For the purposes of this run, assumed
  - All identified units operated at 0.1 lbs/MMBTU
- Applied to:
  - NJ, CT – state identified units
    - NJ ~ < 20%
    - CT ~ < 50%
  - All others –
    - Annual Contribution: <= 2%, and
    - Maximum Hourly Contribution: >= 1%

Ozone Benefits from Controlling High Electrical Demand Day Units

NO_x = 0.1 lb/ mmBtu



Are The Reductions Happening When We Need Them?



Ozone Modeling Conclusions

- Existing control measures “On the Way” and “On the Books” will not bring the region into attainment.
- Steep across the board emission reductions appear to be necessary
- High Electric Demand Day Strategy should be explored

Preliminary Fine Particulate Matter ($PM_{2.5}$) Modeling

Modeling Platform

- Model: CMAQ – Community Multiscale Air Quality Model, Version 4.4
- Time Period: 2002
- Emissions: MANE-VU, LADCO, VISTAS
- Meteorology: MM5

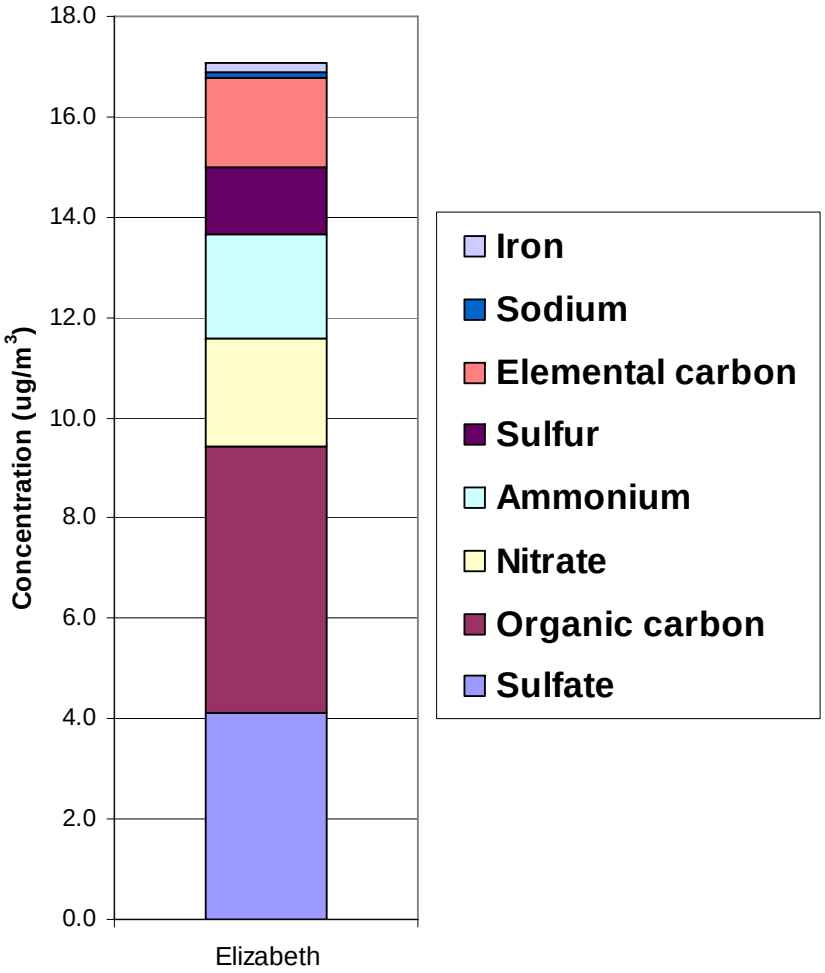
$PM_{2.5}$ Modeling

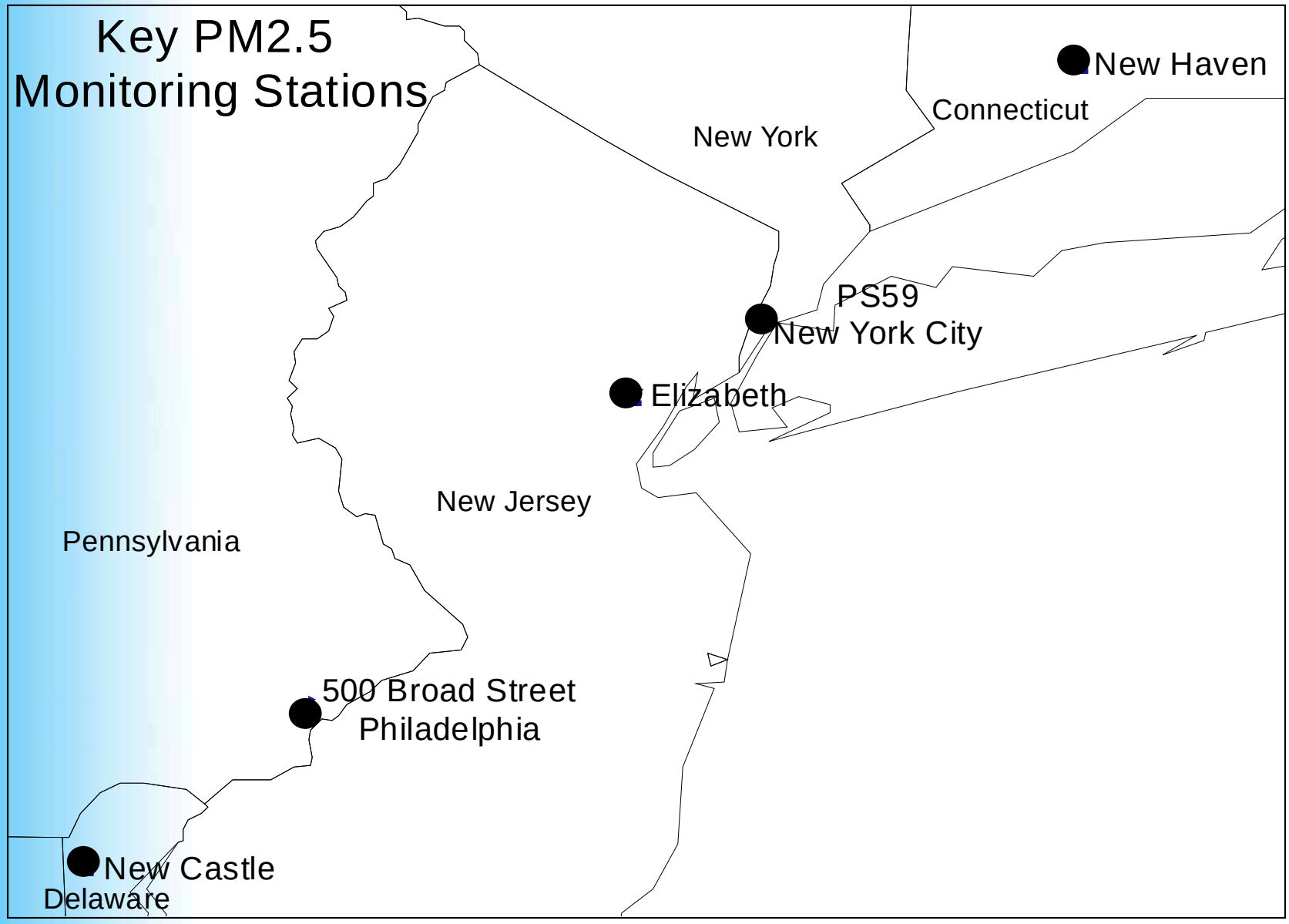
- No Guidance from the USEPA on how to calculate attainment
- Use a method similar to the ozone Relative Reduction Factor (RRF)

Attainment Demonstration Technique

- $PM_{2.5}$ is composed of several constituents
  - Used modeling to estimate changes in species contribution as an approximation for a relative reduction factor
  - Applied to Federal Reference Method Design Values

$PM_{2.5}$ Composition at Elizabeth 2005




Key PM2.5
Monitoring Stations
New Haven
Connecticut
New York
PS59
New York City
Elizabeth
New Jersey
Pennsylvania
500 Broad Street
Philadelphia
New Castle
Delaware

Estimated 2009 Annual $PM_{2.5}$ Concentrations

Key Monitors	2001 – 2003 Design Values (ug/m3)	Estimated RRF	Estimated 2009 Concentration (ug/m3)
State St., New Haven, CT	13.7		13.7
PS59, New York City, NY	17.7	0.94	16.5
Elizabeth, NJ	15.5	0.90	14.0
Broad St., Philadelphia, PA	16.2	0.90	14.7
New Castle, DE	16	0.90	14.5

A lower RRF means more reductions.

$PM_{2.5}$ Modeling Insights

- Need attainment calculation methodological guidance from the USEPA
- Version 4.5 of CMAQ will affect this picture
- Close to being able to demonstrate attainment in most of the area
- Additional emission reductions needed in for New York City and Northern New Jersey and possibly the Greater Philadelphia area
  - Regional
  - Local including diesel

Overall Conclusions

- Ozone – Need additional regional and local emission reductions
- $PM_{2.5}$ – Close but need additional regional and local emission reductions

Success is within reach!